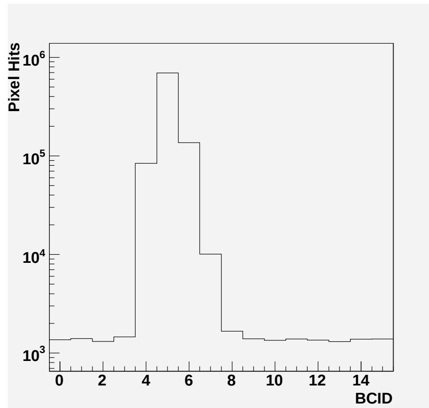

Figure 1: The bunch crossing identifier (BCID) of the pixel hits after masking off the noisy pixels.

1 Cosmic Ray Operation

The detector has been operated with an external trigger generated from a group of scintillators arranged above and below the endcap. The trigger rate of the scintillator system is about 15 Hz, but the rate of muon track crossing all three disks of the endcapA in the sensitive area is about 6 Hz. The detector noise has been studied using several runs with different detector configuration, which shows that the noise signal is uncorrelated with the timing relative to the trigger and that approximately 90% of these noisy pixels were already identified as “special” in the production data and that the total fraction of special pixels is below 0.1%. After removal of the noisy pixels the noise occupancy per pixel and per event readout is of the order of 10^{-10}. Figure 1 shows the bunch crossing identifier (BCID) of the pixel hits after masking off the noisy pixels. We see a clear peak around BCID=5 generated by the cosmic ray hits.

The data of the cosmic ray operation were used to exercise the full offline reconstruction. Digitization parameters have been taken from the characterization tests performed during module production. The simulation produced with these parameters has been found in a good agreement with the data, which provides a good test of the ATLAS pixel detector simulation and makes us confident that the calibration data will be essential for monitoring the evolution of the detector operating conditions in the LHC running.

The tracking studies, especially the ones related to particles passing in the overlap regions between adjacent modules, have been very useful in spotting problems in our geometry description and understanding the detector performance. The characteristic of pixel clustering in the data are checked and agree well with Monte Carlo simulation as shown in Figure 2.

The pixel cluster efficiency is also measured to be close to 100% by check-

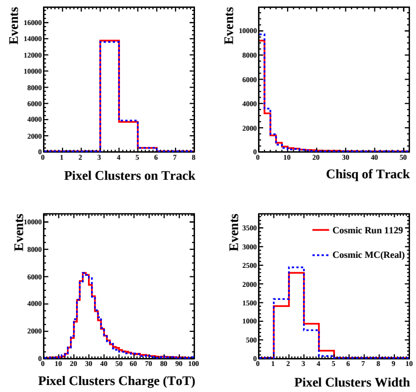

Figure 2: The comparison of the number of pixel hits and the fitted track χ^2 of cosmic tracks (top); the cluster charge of time over threshold (TOT) and the width of the pixel clusters on the tracks (bottom).

ing how often a pair of hits found in the overlap region when the one is expected. There are approximately 24% of tracks cross the overlap region between two adjacent modules in the same disks. For these tracks the extrapolation error from one module to the adjacent one is relatively small and the residual of the nearby hit with respect to the extrapolated track can be used to estimate the relative alignment between the adjacent modules. Figure 3 shows the resolution in short pixel direction (LocX) before and after alignment correction. When using the geometry taken from the detector survey, an initial resolution of 23.0 μm is obtained. After a preliminary alignment this improves to 15.7 μm, which is consistent with the 15.8 μm expected from Monte Carlo simulation. The relative alignment constants are also cross checked between the data and the survey obtained during the detector assembly for the modules with enough overlap hits (≥ 50) and a strong correction between two is clearly visible in Figure 4 which indicates that the survey is a reliable starting point for the final detector alignment in the future.

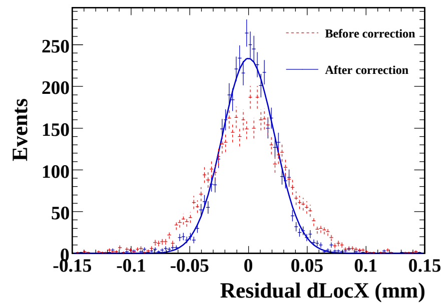

Figure 3: Distribution of overlap residual in LocX before and alignment corrections.

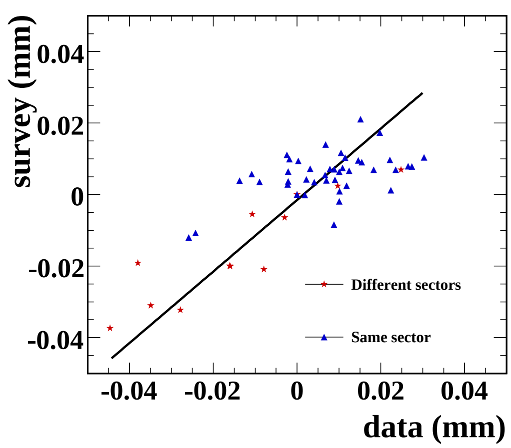

Figure 4: A comparison between the data and the survey obtained during the detector assembly for the modules with enough overlap hits (≥ 50). The data seem keeping track of the survey well for the modules cross in the adjacent sectors (blue triangle) while not so well for the modules in the same sectors (red star), which is due to the limited statistic that is insensitive to a small alignment for the modules in the same sector.